



Armed Forces College of Medicine AFCM



Regulation of food intake

By

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INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture the student will be able to:

1. Define hunger and satiety
2. Describe the nervous regulation of food intake
3. Explain the role of different centers involved in food intake
4. Explain the role of different neurotransmitters and hormones that influence feeding behavior
5. Describe the short term and long term regulation of food intake

Dietary balance



Food intake is essential for life



It maintains a normal energy balance in the body & body weight constant

It is reg. by **BIOLOGICAL CONTROL SYSTEM**

Food intake is controlled by sensation of hunger & appetite



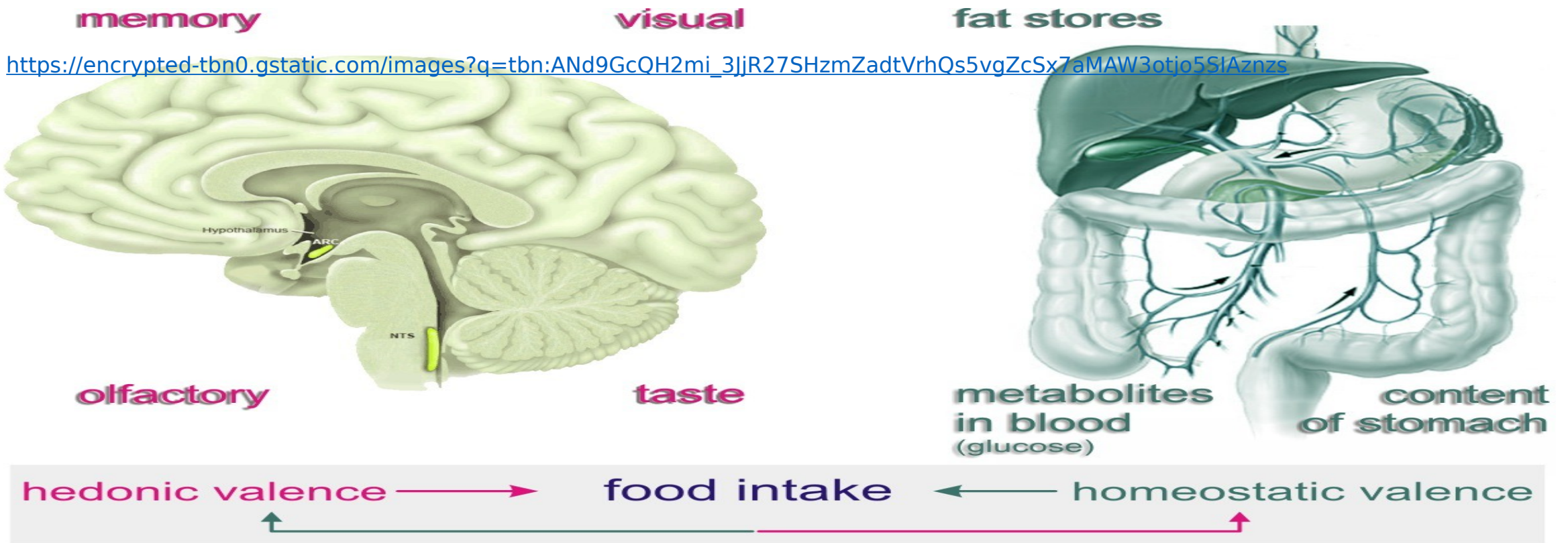
Hunger: The need for food that might be associated with hunger pain

Appetite : The desire for specific types of food

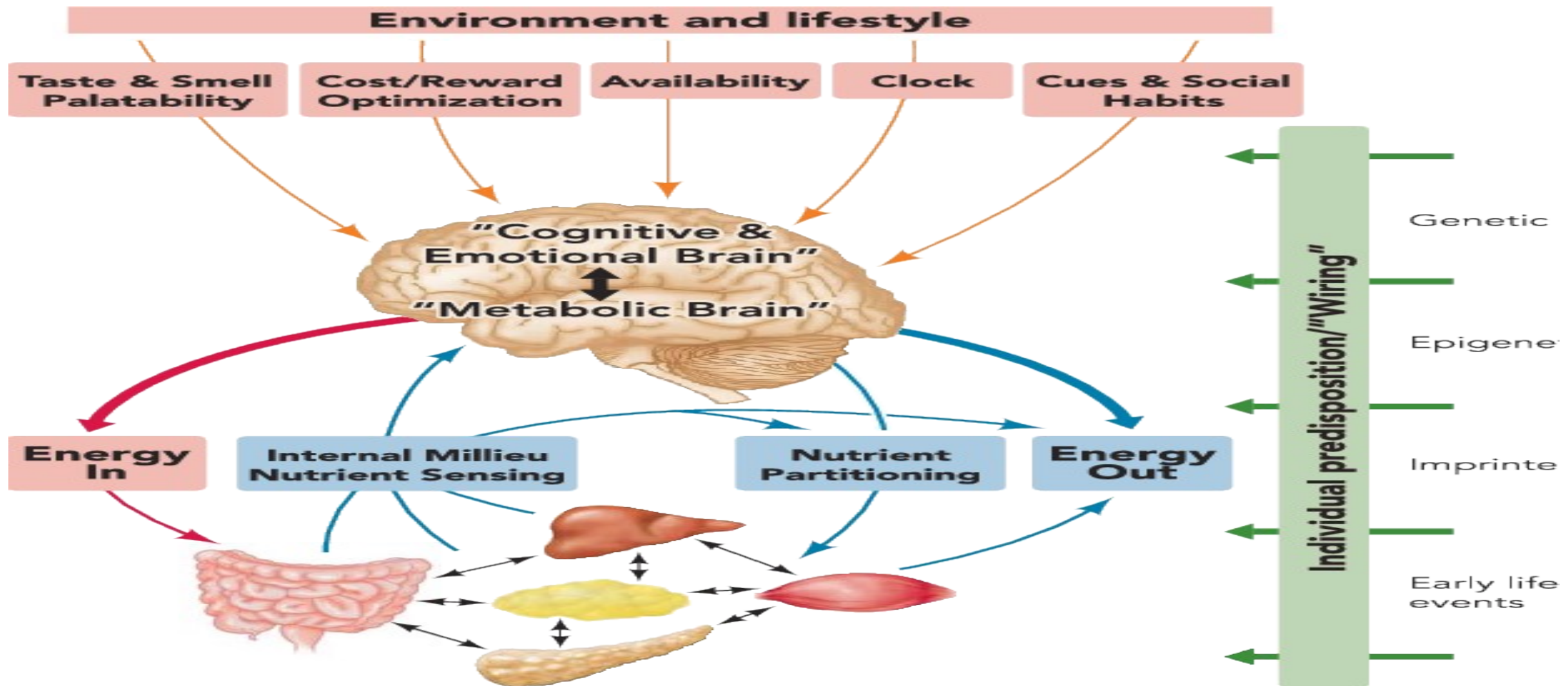
Satiety: Sensation of fulfilment after taking food

It tell us when we have enough & it operates via inhibition of FC ?? after food ingestion

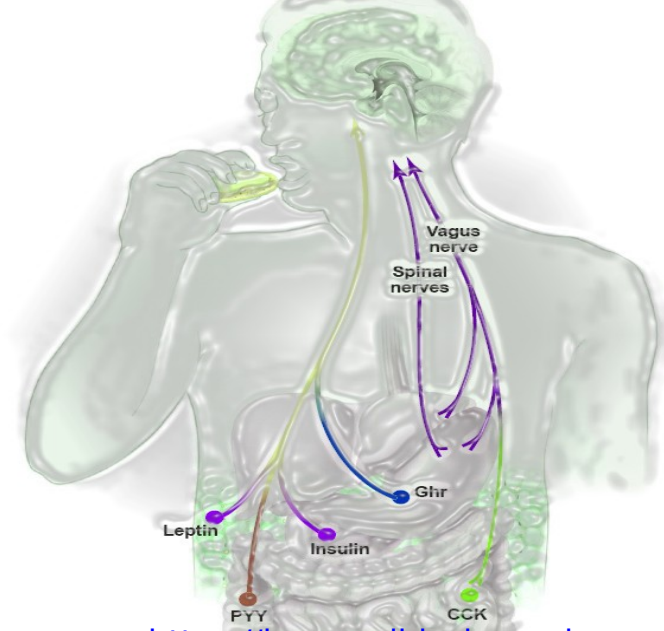
Set point: There is a point for body weight & activity of the hypothalamus to control food intake to keep body weight constant



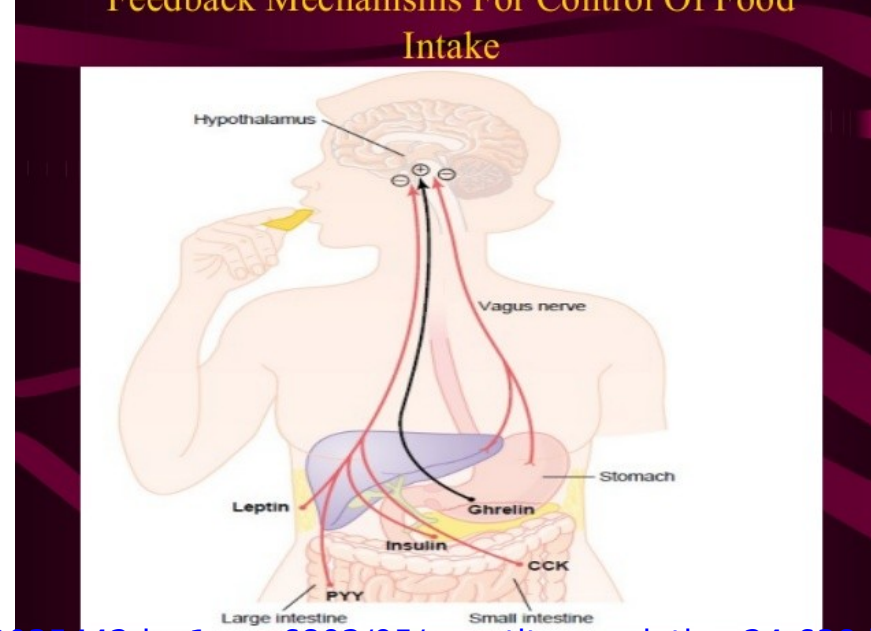
Each of feelings (hunger or appetite) is influenced by environmental and cultural factors, as well as by physiologic controls that influence specific centers of the brain, especially the hypothalamus



https://www.researchgate.net/profile/Huiyuan_Zheng/publication/5451434/figure/fig1/AS:341282137362435@1458379410242/Schematic-diagram-showing-the-major-factors-determining-neural-control-of-appetite-and.png

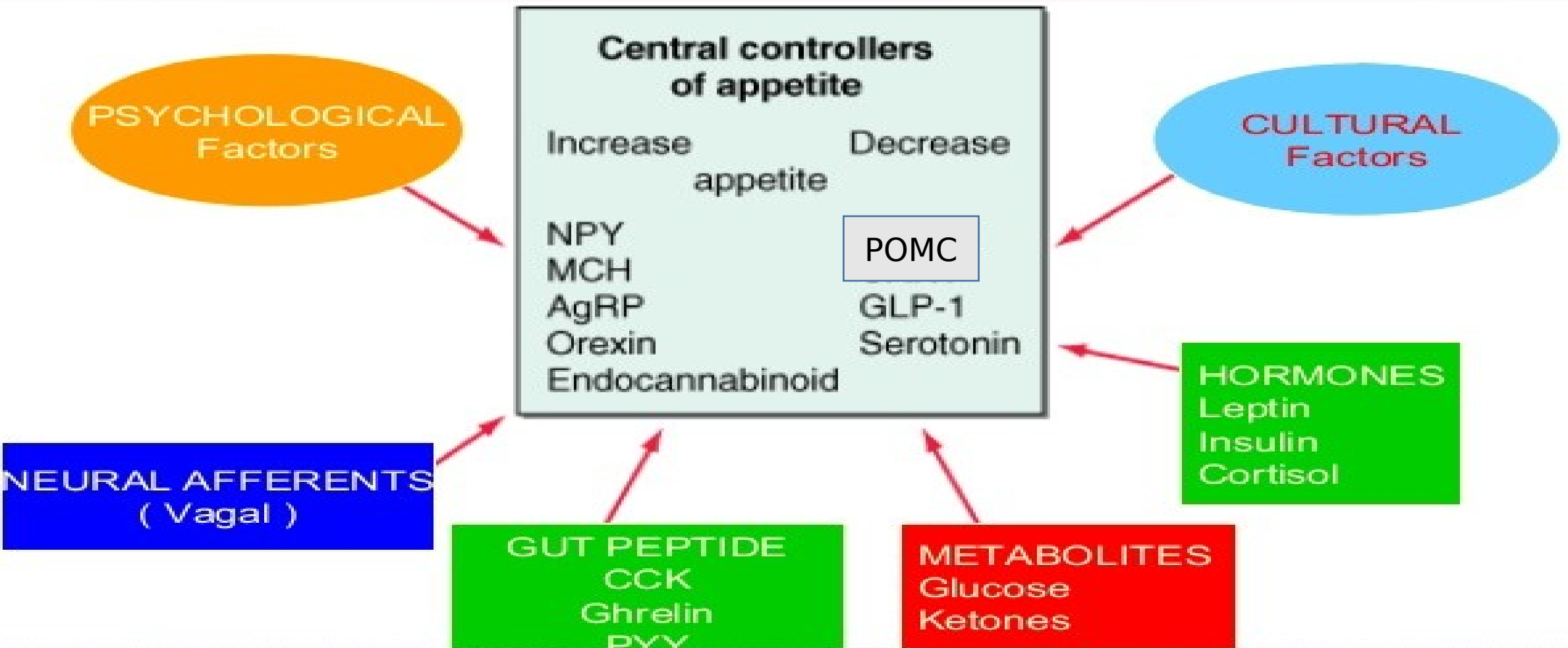


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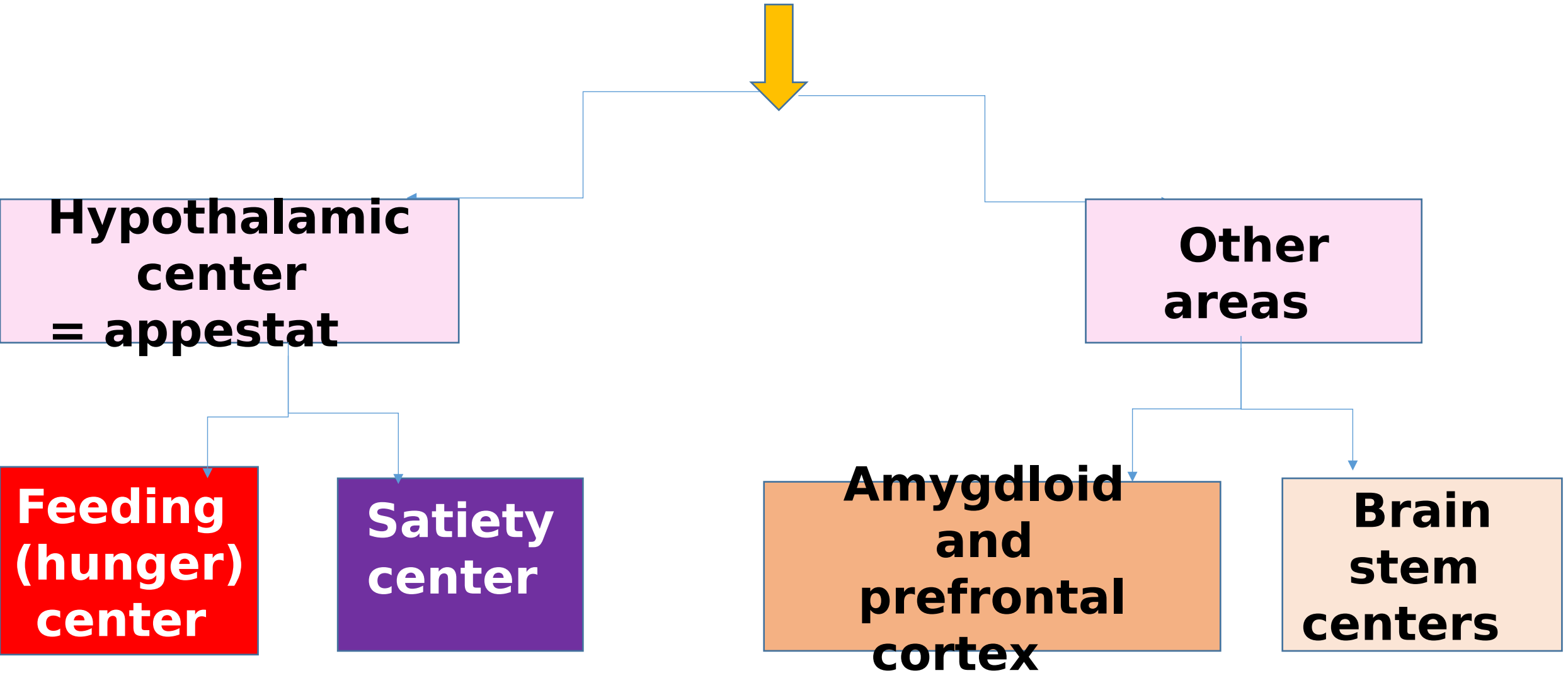
provide sensory information about stomach filling”, chemical signals from nutrients in the blood (glucose, amino acids, and fatty acids) that signify satiety, signals from gastrointestinal hormones (ghrelin, CCK, PYY,...), , signals from hormones released by adipose tissue, and signals from the cerebral cortex (sight, smell, and taste) ->

The Factors That Regulate Appetite Through Effects On Central Neural Circuit



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Nervous regulation of food intake



Nervous regulation of food intake



Amygdala
cortex

These areas are parts of the limbic system

Their destruction □

Omniphagia “the person eats all sorts of food with loss of control on type and quantity of food”

Brain stem
centers

Brain stem
contains
centers that
control:
* Swallowing
* Chewing

Feeding and Satiety Center



Feeding
center
“Lateral
hypothalamus”

Inhibition

Satiety center
“Ventromedial nuclei of
hypothalamus”





Under normal physiological conditions, appetite and food intake are well balanced and continues in a cyclic manner These centers are regulated by the following mechanisms

i.
**Glucostatic
mechanism**

ii.
**Lipostatic
mechanism**

iii. **Peptide
mechanism**

iv.
**Hormonal
mechanism**

v.
**Thermostatic
mechanism**

Hypothalamic centers



1- Feeding center "FC"

Site

Lateral hypothalamus

Effect of its stimulation

Eating

Excessive stimulation □

Hyperphagia i.e.

Excessive eating

Effect of its inhibition

Satiety

Its destruction

Fatal anorexia

NB.: This center is

tonically

active

*It is inhibited
by feeding*

transiently

Hypothalamic centers



2nd Satiety center “SC”

In the Ventromedial nuclei of
hypothalamus

Site

Effect of its
stimulation

- Satiety (i.e.)
aphagia

Effect of its inhibition

Increase feeding

Effect of its
destruction

Destruction □
hyperphagia with
extreme obesity

Neurotransmitters and hormones that influence feeding behavior are categorized to:



1- Orexigenic substances “that stimulate feeding”

Neuropeptide Y (NPY), and agouti-related protein (AGRP),,,,,,. Activation of the of the NPY-AGRP neurons□

Increase food intake
and reduces energy
expenditure.

2- Anorexigenic substances “that inhibit feeding”

Proopiomelanocortin (POMC) neurons that produce a melanocyte-stimulating hormone (α -MSH) together with cocaine- and amphetamine-related transcript (CART), neurotensin and CRH,, Activation of the POMC neurons

Decrease food
intake and
increases energy
expenditure

Which of the following is an anorexigenic?

- 1) AgRP, agouti-related protein.
- 2) NPY, neuropeptide Y
- 3) Orexin
- 4) α - melanocyte stimulating hormone.

Which of the following is anorexigenic substances ?

- 1) AgRP, agouti-related protein.
- 2) NPY, neuropeptide Y
- 3) Orexin
- 4) α - melanocyte stimulating hormone.



Neurotransmitters and Hormones That Influence Feeding and Satiety Centers in the Hypothalamus

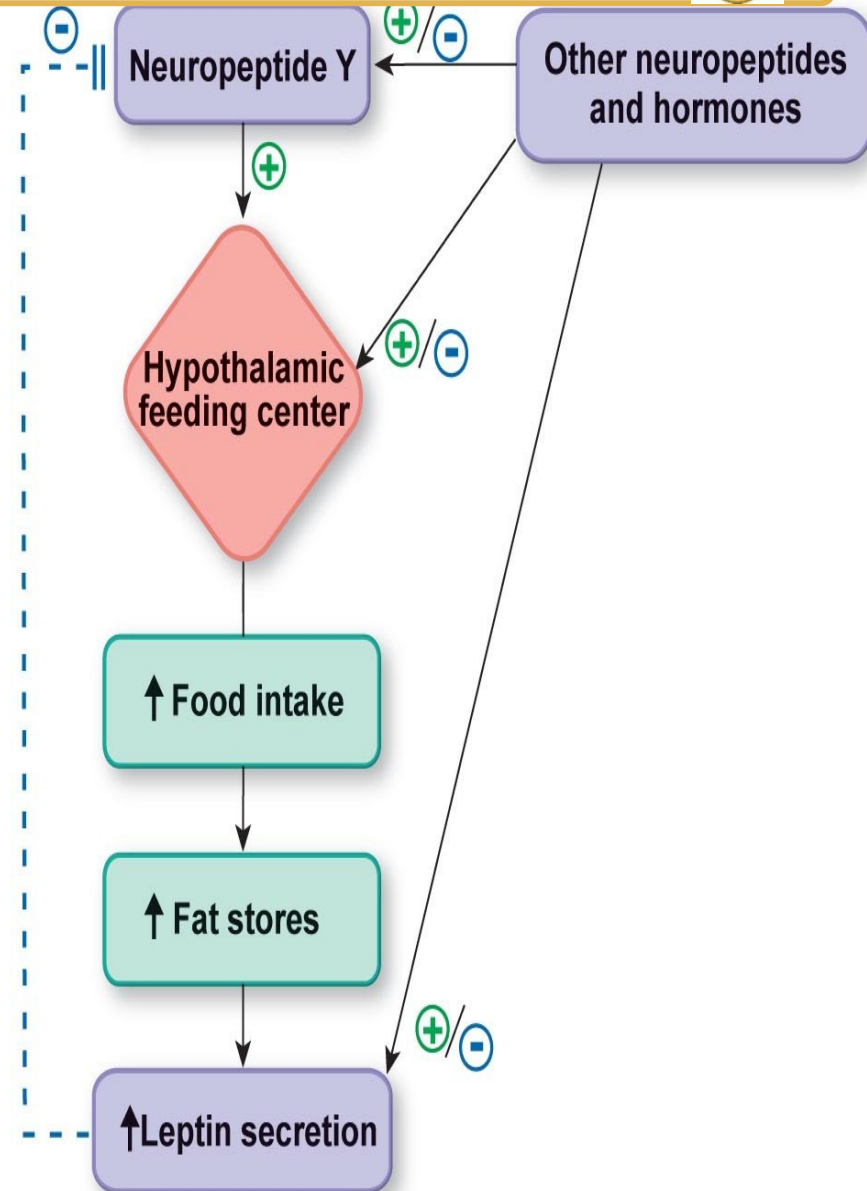
Decrease Feeding (Anorexigenic)	Increase Feeding (Orexigenic)
α -Melanocyte-stimulating hormone (α -MSH)	Neuropeptide Y (NPY)
Leptin	Agouti-related protein (AGRP)
Serotonin	Melanin-concentrating hormone (MCH)
Norepinephrine	Orexins A and B
Corticotropin-releasing hormone	Endorphins
Insulin	Galanin (GAL)
Cholecystokinin (CCK)	Amino acids (glutamate and γ -aminobutyric acid)
Glucagon-like peptide (GLP)	Cortisol
Cocaine- and amphetamineregulated transcript (CART)	Ghrelin
Peptide YY	(PYY) Endocannabinoids

Guyton and Hall "Textbook of Medical Physiology", 12th edition, Chapter 71 Dietary Balances; Regulation of Feeding; Obesity and Starvation; Vitamins and Minerals, unit 13, Table 71-2 Neurotransmitters and Hormones That Influence Feeding and Satiety Centers in the Hypothalamus

Leptin



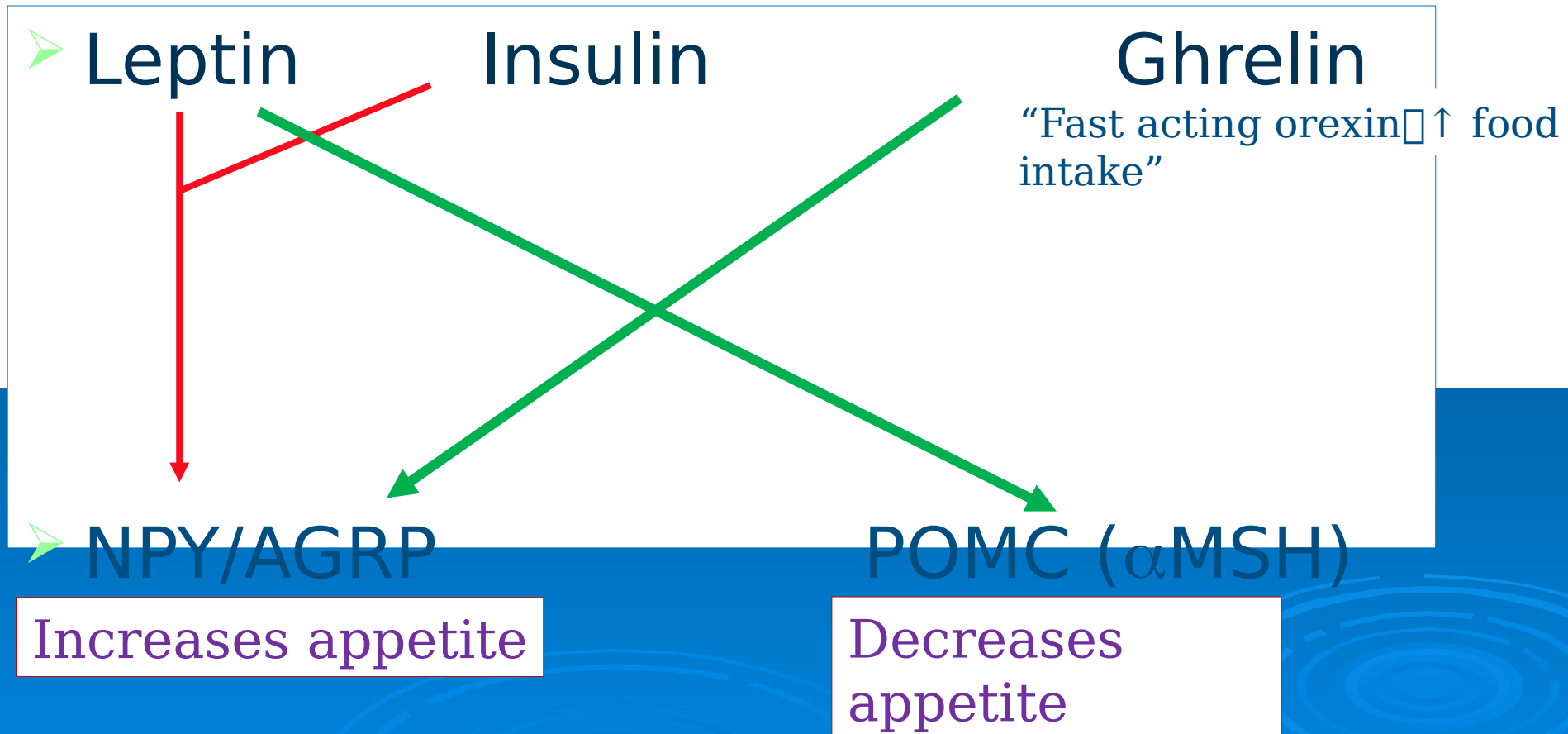
- Leptin is a hormone produced by the adipose tissue
- It tells the brain about the size of fat stores
- It inhibits the Feeding Center via a negative feedback system to keep body WT constant
- By inhibit the release of Neuropeptide-Y that enhances eating activity



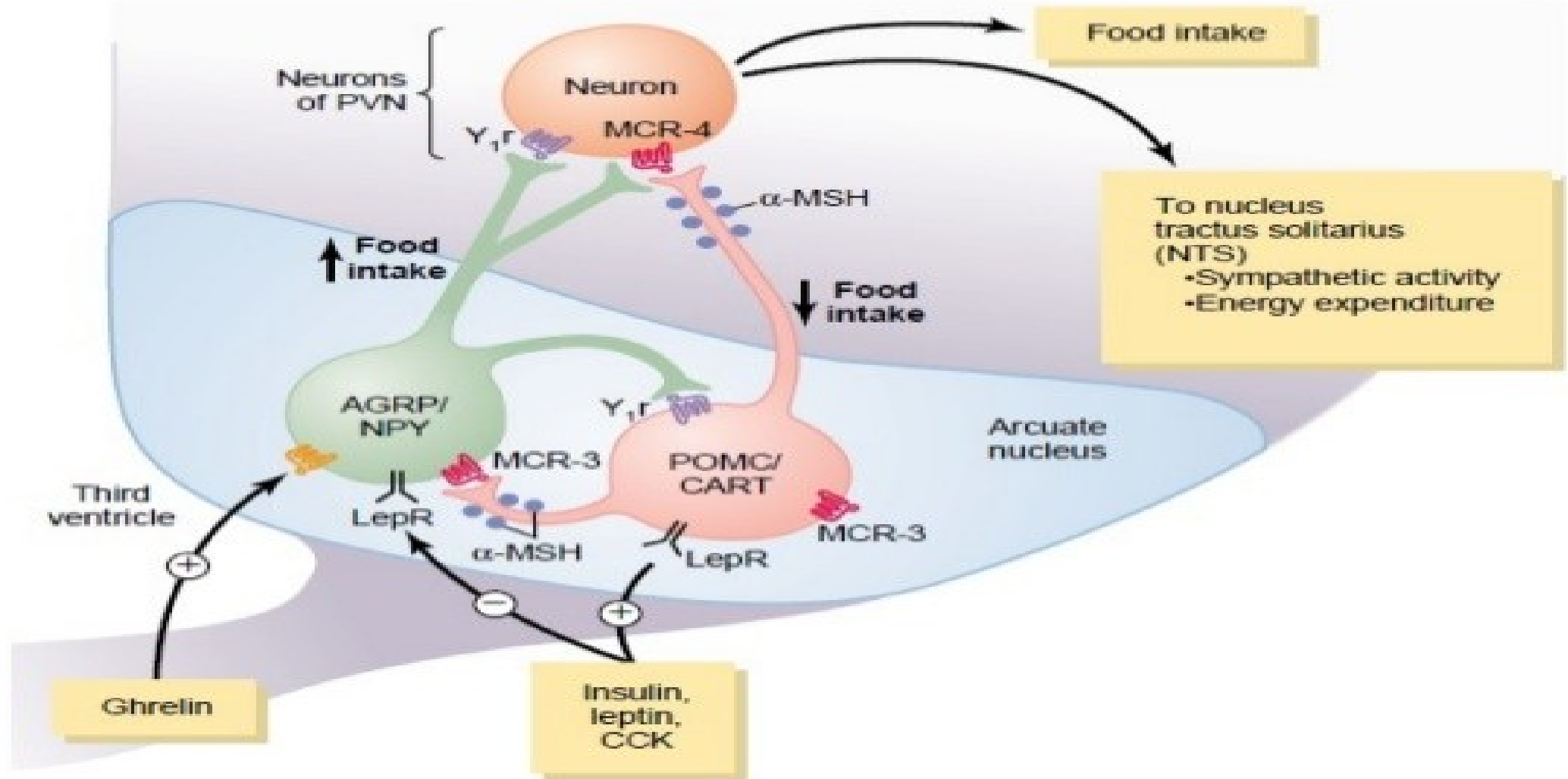
Neurotransmitters and hormones that influence feeding behavior



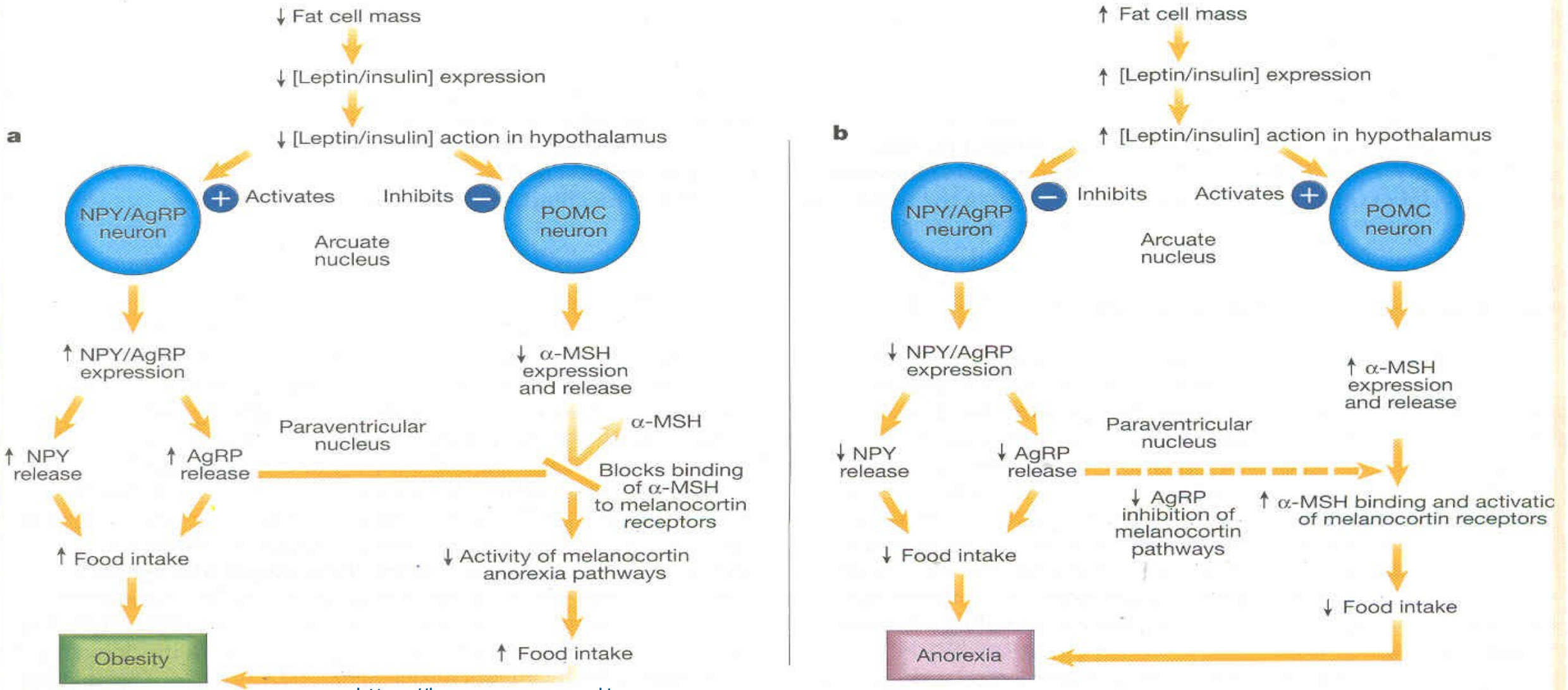
Red arrow = Inhibitory & Green = Stimulatory



Neuron And Neurotransmitters In The Hypothalamus That Stimulate Or Inhibit Feeding

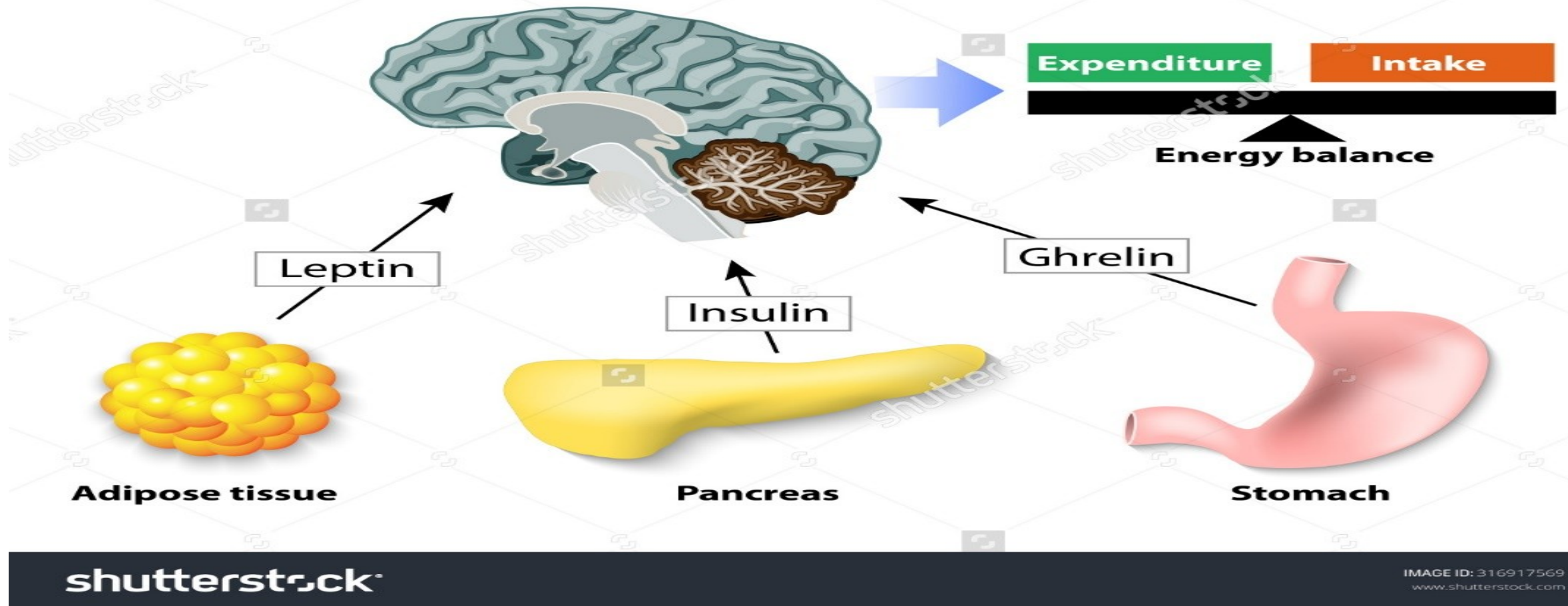


The neurotransmitters and hormones that influence feeding behavior



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CONTROL OF FOOD INTAKE



<https://previews.123rf.com/images/designua/designua1508/designua150800022/44488188-control-of-food-intake-human-hormones-leptin-insulin-and-ghrelin-leptin-and-the-regulation-of-energy.jpg>

Factors regulating food intake



I- Long term regulation

II- Short term regulation

a-

**Nutritional
regulation**

b-

**Effect of
body
temperature**

I- Long term regulation



a- Nutritional regulation

Fall "below normal" nutrient stores □ (+)
Feeding center □
Hunger sensation

Abundant nutrient stores □ (-)
Feeding center □
Satiety

b- Effect of body temperature

Cold
Increase activity of the feeding center

Heat
Decrease activity of the feeding center

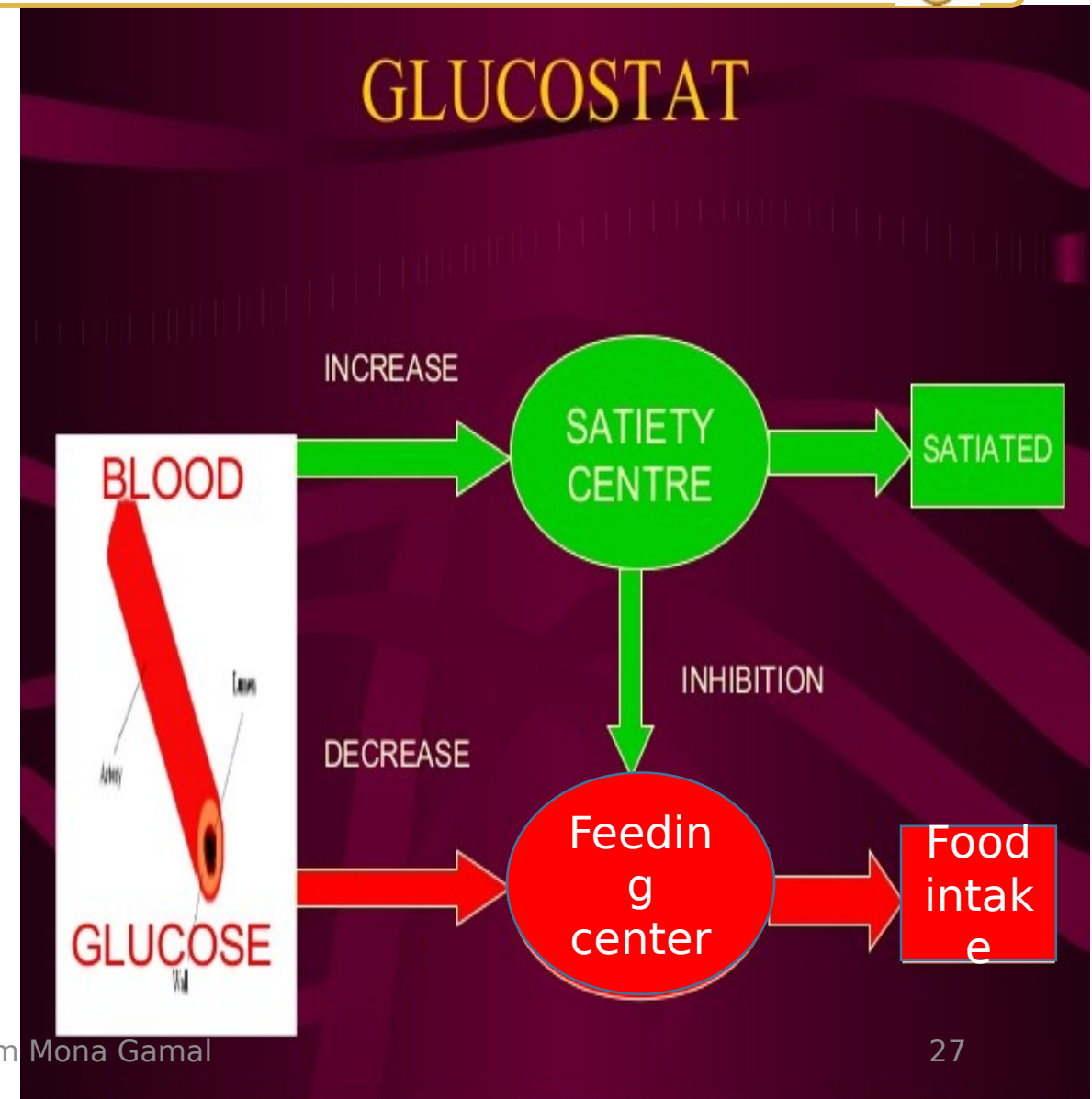


Glucostatic theory

The activity of satiety center is determined by rate of glucose utilization within its cells:

↑ Increase blood glucose level → ↑ increase activity of satiety center → a sense of satiety.

↓ Decrease blood glucose level → ↑ increase activity of feeding center → feeding sensation

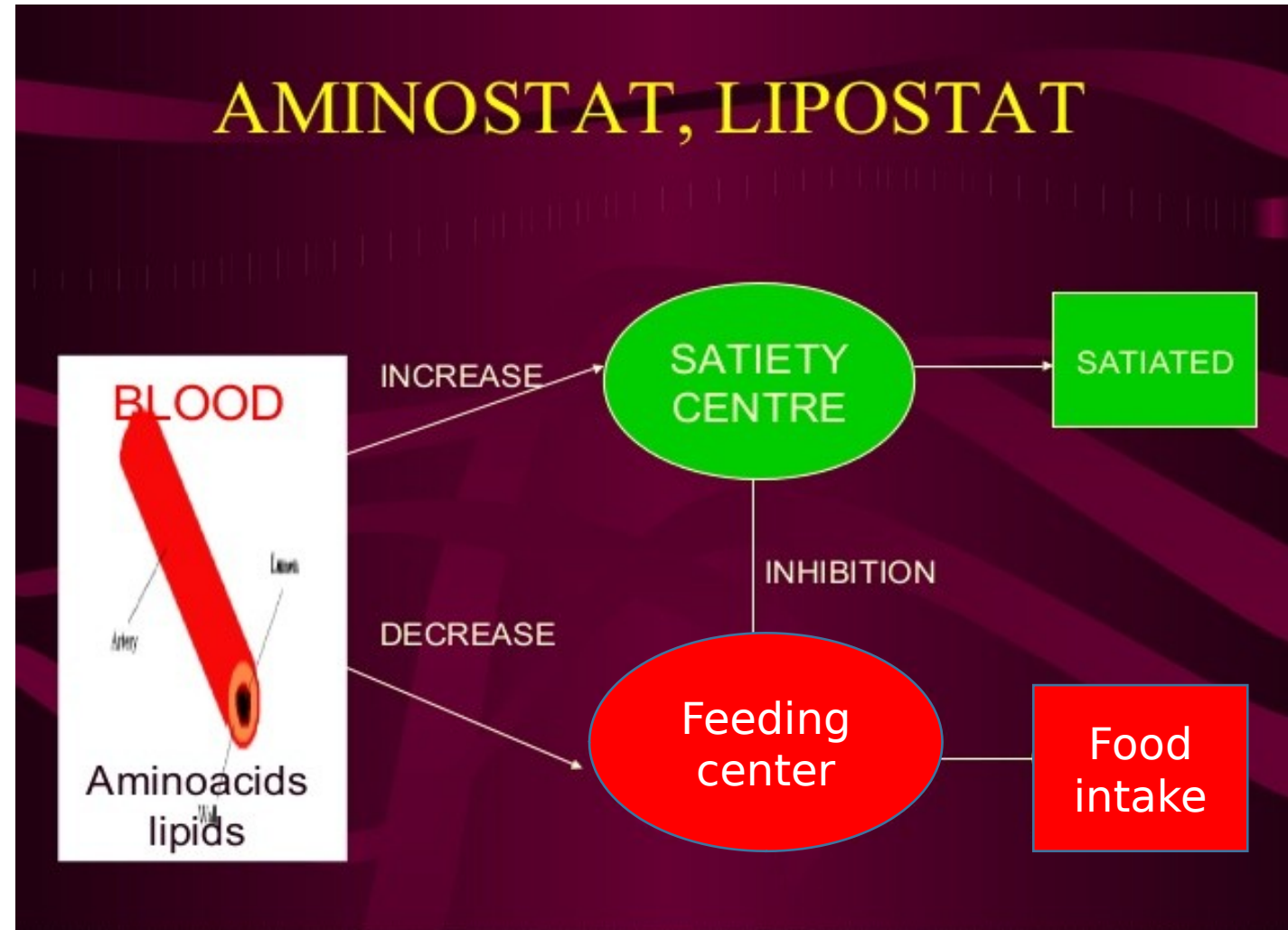


Lipostatic and Aminostate theory



The activity of satiety center is determined by amount of stored fat in the body

It may be also determined by the circulating metabolic products of lipid and amino acids.



Factors responsible for short term regulation



The aim of this regulation is to prevent over eating

A- Gastrointestinal filling: Filling of the stomach and duodenum -> inhibitory impulses via vagus $\square$ (-) FC

B- Hormones: Certain hormones after food intake $\square$ (-) FC, e.g. CCK
On the other hand some hormones stimulate feeding center

C - Other factors such as chewing, tasting and swallowing $\square$ transient (-) FC “which is weak and takes place within (20-40) minutes”

1-Alimentary factors

regulation



2- Other factors regulate meal quantity & frequency The aim of this regulation is to prevent over eating stop eating” “≈ causes the person to

a- Increased MR □ raise body temp. □ (+) Satiety center

b- Increased insulin dependent - glucose utilization □ (+) Satiety C.

c- Signals coming from stretch & chemo-receptors in the stomach & duodenum due to presence of food in the GIT

d- Previous experiences to sight, smell and taste of food affect food intake

e- Stress : Stim. Food intake via stim. of hunger sensation

a) Orexin
melanocyte hormone

a) Orexin b) Ghrelin c) POMC

Q3. Which of the following inhibits feeding center?

a) **Orexin**

b) CCK

c) α -

melanocyte hormone

Q2. Which of the following decreases the food intake?

a) Orexin

b) Ghrelin

c) POMC

Q3. Which of the following inhibits feeding center?

SUGGESTED TEXTBOOKS



1. Ganong's "Review of Medical Physiology", 25th edition, chapter 26, pages 485-487
2. Guyton and Hall "Textbook of Medical Physiology", 12th edition, chapter 71, pages 843-849
3. Sembulingam "Essentials of Medical Physiology", 6th edition, chapter 149, Section 10, pages 858-860

